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Flood Management Enhancement Using Remotely Sensed Data

Fifth Milestone Period Report

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INTRODUCTION

Background. SENTAR, Inc., entered into a cooperative agreement with NASA Goddard Space Flight Center (GSFC) in December 1994. The intent of the NASA Cooperative Agreement is to stimulate broad public use, via the Internet, of the very large remote sensing databases maintained by NASA and other agencies, thus stimulating U.S. economic growth, improving the quality of life, and contributing to the implementation of a National Information Infrastructure. SENTAR heads a team of collaborating organizations in meeting the goals of this project. SENTAR's teammates are the NASA Marshall Space Flight Center (MSFC) Global Hydrology and Climate Center (GHCC), the U.S. Army Space and Strategic Defense Command, and the Alabama Emergency Management Agency (EMA).

For this cooperative agreement, SENTAR and its teammates are accessing remotely sensed data in the Distributed Active Archive Centers, and other available sources, for use in enhancing the present capabilities for flood disaster management by the Alabama EMA. The project is developing a software system that addresses prediction, warning, and damage assessment for floods. The objectives of the prototype system are to demonstrate the added value of remote sensing data for emergency management operations during floods and the ability of the Internet to provide the primary communications medium for the system. The key to achieving these objectives will be the development of the Emergency Management Tool that will provide an integrated interface for the emergency operations staff to acquire and manipulate source data and data products to generate and distribute new data products to support their mission. The prototype system will also establish a systems infrastructure that is easily expandable to include additional flood-related data and models or to other disasters with their associated remote sensing data requirements and distributed data sources.

Scope. This report covers the work performed during the fifth milestone period of the project, which began on 19 February 1996 and ended on 7 June 1996.

Purpose. The purpose of this report is to: 1) document the successful completion of all the fifth period milestones and 2) to provide a status of the significant accomplishments, problems encountered, and requests for assistance from NASA during the fifth milestone period and plans for the sixth milestone period. This information is intended to provide project insight to the NASA Technical Officer to assure that all necessary steps are being taken to maximize the probability of success.

SUMMARY OF ACTIVITIES

Significant Accomplishments. SENTAR had three products for the fifth milestone period. These were:

1. An end of milestone period status report
2. An experiment/demonstration plan for the prototype system
3. Completion of 50% of the software modules.

These three products have been successfully completed. This report constitutes the completion of the first product. The second product is included as an attachment to this report; the third is described in the following paragraphs, along with a summary of the other project accomplishments, activities, and problems during this milestone period. The report concludes with the plans for the next milestone period.

Experiment/Demonstration Plan. An experiment/demonstration plan was developed this milestone period. This plan is designed to conduct a series of two simulated flood events in which the overall prototype system is demonstrated. The activities of the plan will exercise the developed and integrated components as a system to show overall functionality and to examine how the prototype system works with the existing plans and procedures at the Alabama EMA Emergency Operations Center (EOC). Each experiment/demonstration will focus on one of the geographical areas of the geographical information system (GIS) data coverages developed for this project. In addition, each experiment/demonstration will exercise particular aspects of the prototype system. There will be one experiment/demonstration involving a hurricane that makes landfall on the Florida panhandle and heads north through the southeast counties of Alabama, causing flooding along several rivers and streams. The other experiment/demonstration will consist of flooding in northern Alabama resulting from severe and prolonged spring thunderstorms. In both cases, Landsat TM images will be used as the backdrop imagery in the GIS for the normal, or non-flooded, view. Then for the visualization of the flood, Landsat TM imagery will be used as a backdrop and as a land/water derived classification to locate and assess the flood regions in one case and aerial photography will be used in the other.

The actual staff of the Alabama EMA will be used to operate the components of the system that are located at the EOC and at the county EMA offices. The experiments/demonstrations are developed in separable portions since the complete demonstration will take several days. Also, the schedule has to be easily modifiable since the actual Alabama EMA mission will always take precedence over these activities, and thus, there may be several interruptions in the execution of the experiments/demonstrations that could involve extended periods of time.

The actual experiment/demonstration plan is presented in a separate report. It describes the specific objectives, resources, activities, and anticipated results for the two simulated floods. During the next milestone period, SENTAR will work with the Alabama EMA staff to integrate their emergency operations procedures into these plans.

Software Module Development. The prototype system with custom-built software consists of a set of commercial-off-the-shelf (COTS) applications integrated under a common user interface, called the Emergency Management Operational Tool. The design makes extensive reuse of existing software products to provide system functionality wherever possible, and in particular, the existing and planned software at the Alabama EMA. Where these software packages will not meet the functional needs of the prototype system, SENTAR is developing the required software applications and utilities. The list of the software components to be developed for this project consists of:

1. Emergency Management Operational (EMO) Tool
2. Vector/Raster Data Formatter
3. Data Parsing/Extracting Scripts
4. Data Retrieval Scripts
5. ArcView Interface Scripts
6. ARC Macro Language (AML) Utilities.

Where the EMO Tool will reside on the EOC staff PCs, the vector/raster data formatter will operate on PCs at the Data Processing Center, the data parsing/extracting scripts and data retrieval scripts will operate on the Sun server at the EOC; refer to Figure 1. The ArcView interface scripts and AML utilities are executable code for developing the system or databases, but are not actually part of the prototype system.

As written and planned in the prototype system design concept, SENTAR's goal was to complete 50% of the software modules by end of fifth milestone. This goal has been met with the development of the EMO Tool graphical user interface, the vector/raster data formatter, and the data retrieval scripts; and with the elimination of about half the originally required AMLs for data coverage development.

The following paragraphs provide details on the composition and status of each of the six software component that are to be developed. Also provided is the work remaining to be performed during the next milestone period. For those components that have been developed by SENTAR, information is provided as to what platform operating system is used and what software language the application was created in.

<u>EMO Tool.</u> The EMO Tool is the primary application being developed by SENTAR for delivery to the Alabama EMA. The tool's primary purpose is to be the integrated interface for the operational staff, thus allowing COTS applications to be integrated into one package. The interface to the EMO Tool easily allows the EOC staff to acquire and view retrieved data such as GOES, and radar images along with NWS forecasts and warning bulletins. Other functionality of the tool will be the ability to execute and spawn external applications at the touch of a button, most notably the ArcView GIS software, without having to locate icons within program groups or search in directory paths.

The prototype tool is being developed under the Window 3.1 operating system and is running as a 16-bit application. Using the Visual Basic 4.0 language, the tool has been composed with pre-developed drop and drag components, making future enhancements easy to add on. The tool is composed of four modules in various stages of development. Overall, the tool is 50% complete at the end of this milestone.

The tool has been broken down into 4 modules with the first being the graphical user interface (GUI) (see Figure 2). The initial version of the GUI is developed and is composed of a variety of push buttons and pull down menus. These buttons and menus give choices to the staff as to what area they might be interested in within the state of Alabama for viewing radar or weather bulletins from that location. The GUI development is 90% complete; another 10% of GUI development is anticipated for user feedback changes and to add new COTS packages or additional data and imagery retrieval locations.

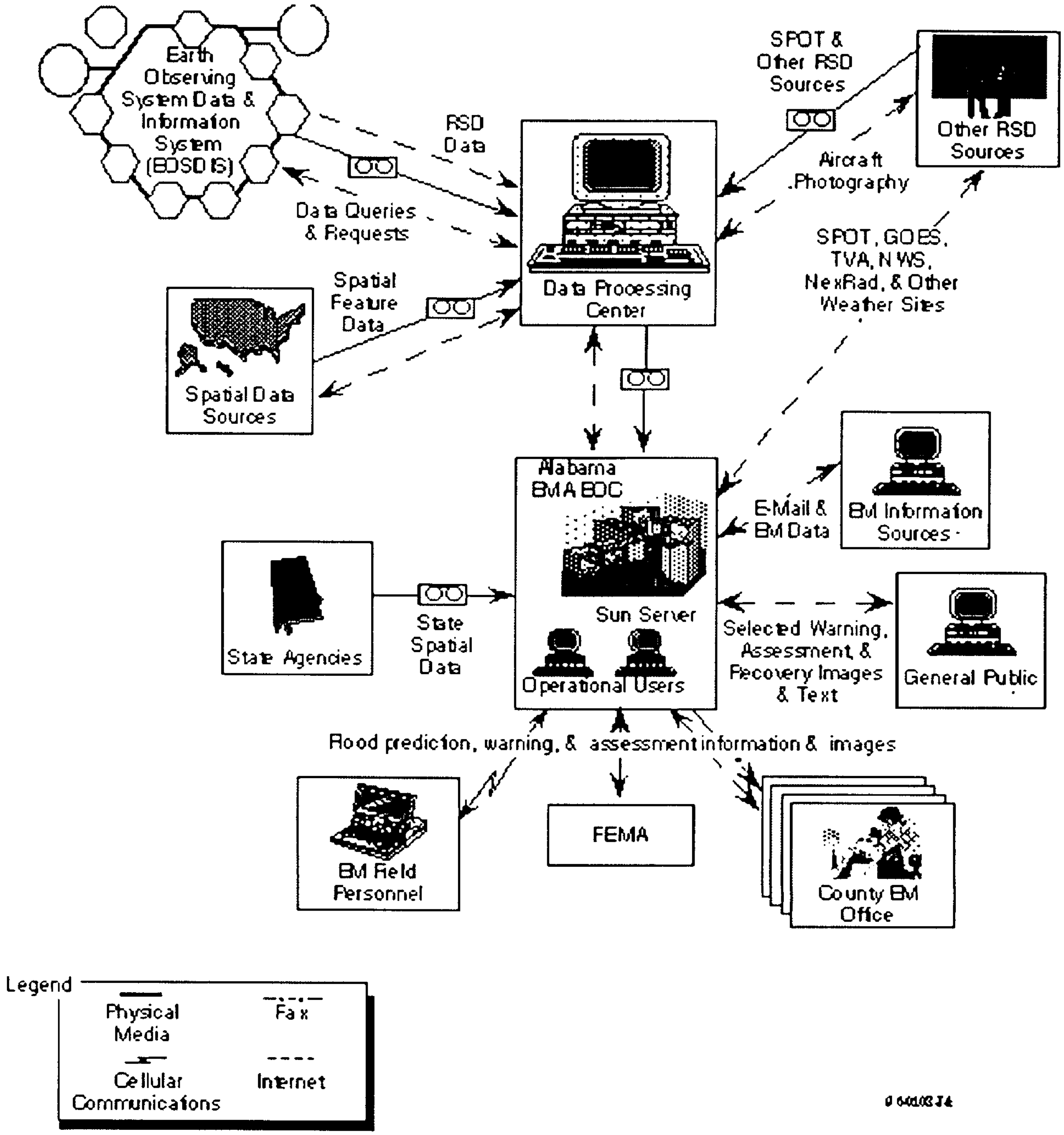

Figure 1. Prototype system concept

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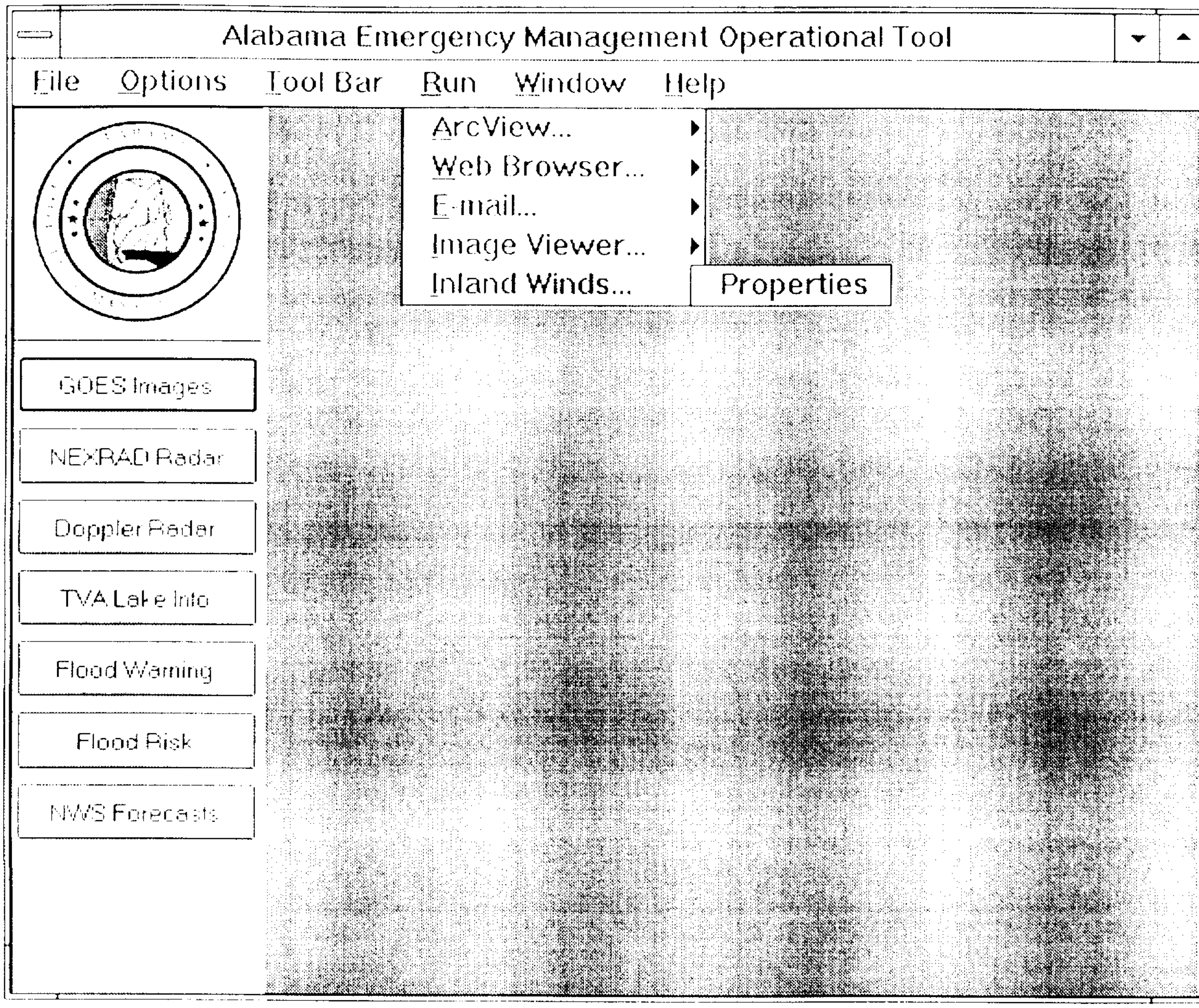

Figure 2. Prototype of Emergency Management Operational Tool

The second module is an internal viewer for the tool. Although the tool will support an external web and resource browser such as Netscape or Mosaic, development called for the operation of a hands-off internal viewer. The internal viewer will support limited functions such as pan and zoom but will not allow the operator to manipulate the image after it has been loaded. This module is currently in the design phase (approximately 20% complete).

The third module is composed of the internal source code for the image and text file retrievals and pop, pull and refresh code for the windows functions. The source data file retrievals are performed outside the tool application on the SUN server, utilizing the data retrieval scripts which are described later. The EMO Tool will instead take images and text files from designated storage locations on the server and load them into the internal browser. The reason for extracting these files from the server rather than directly from the remote computers, is to conserve the bandwidth of the EOC's Internet connection. Percentage complete for this module is 30%.

The fourth and final module is the composition and development of help file pages. As with many commercial packages, help files come with help documents separate from the application itself. Though the use of the file menu system in the EMO Tool, internal on line help information will be supported. These files will provide full instructions for each button and itself. Though the use of the file menu system in the EMO Tool, internal on-line help information will be supported. These files will provide full instructions for each button and menu and provide the user with pictures of how to operate the tool. This module is still in the design phase.

Vector/Raster Data Formatter. SENTAR is using the MapiX remote sensing software to perform the image processing functions of georeferencing and feature classification. MapiX's ability to perform 3rd-order georectification provides the SENTAR team with the ability to work with imagery from high-end satellite data down to low quality 35m aerial photography on a standard PC platform. The limitation to using MapiX was the inability to import processed images into the ARC/INFO and ArcView packages while retaining the georeferencing information because of proprietary file formats. With help from the MapiX developer, Delta Data Systems, by providing the output file format information, SENTAR was able to develop the vector/raster formatter.

The vector/raster data formatter developed by SENTAR is capable of taking high to low-end imagery from MapiX and converting it into the common Band Interleaved by Line (BIL) raster file format for both single and multiband images. The formatter is capable of creating various description files to be associated with the BIL raster file: a header file that describes the layout of the image pixel data, a color file that describes the image color map, a statistics file that describes image statistics for each band of the image, and two other text files that break down the internal components of the image file and also describe the format of the first channel. These ASCII text files are generated when the formatter is executed on a MapiX image.

The formatter itself was developed using the Visual C++ language. It takes full advantage of new input/output stream functions in C++ due to the size of the complex imagery. The utility itself goes by the name AIF2BIL because of its creation of a BIL file from MapiX's .AIF file. The percent completion for the five modules that compose the reformatter is 100%.

Future enhancements are planned for the formatter. The development of a GUI front-end using custom controls is scheduled for later in the project, since it is not necessary for operation of the utility and is only planned for use by SENTAR staff at the Data Processing Center (versus at the EOC by the emergency management staff). Figure 3 illustrates the design for the AIF2BIL GUI.

Data Retrieval Scripts. SENTAR's design concept makes extensive reuse of existing software products to provide system components wherever possible. In the case of data retrieval scripts it was in the best interest of the project to reuse pre-existing scripts and utilities from the University of Texas and RSPAC.

SENTAR developed a new data retrieval script by combining and modifying the pre-existing scripts. The result is a UNIX-based script which will reside on the SUN server at the EOC. The script is composed of function calls to a small Perl utility called url_get. Url_get was written to retrieve documents specified by their Uniform Resource Locator (URL) on the World Wide Web. Through these calls, the script will download radar, NEXRAD and satellite GIF/JPG images, along with gopher NWS forecast ASCII text pages. Other portions of the script will use the standard File Transfer Protocol (FTP) to download files from those sites that support direct anonymous FTP services. All of the ASCII text files and images will be stored on the EOC server. These files will then be retrieved from the server by the EOC staff via the EMO Tool.

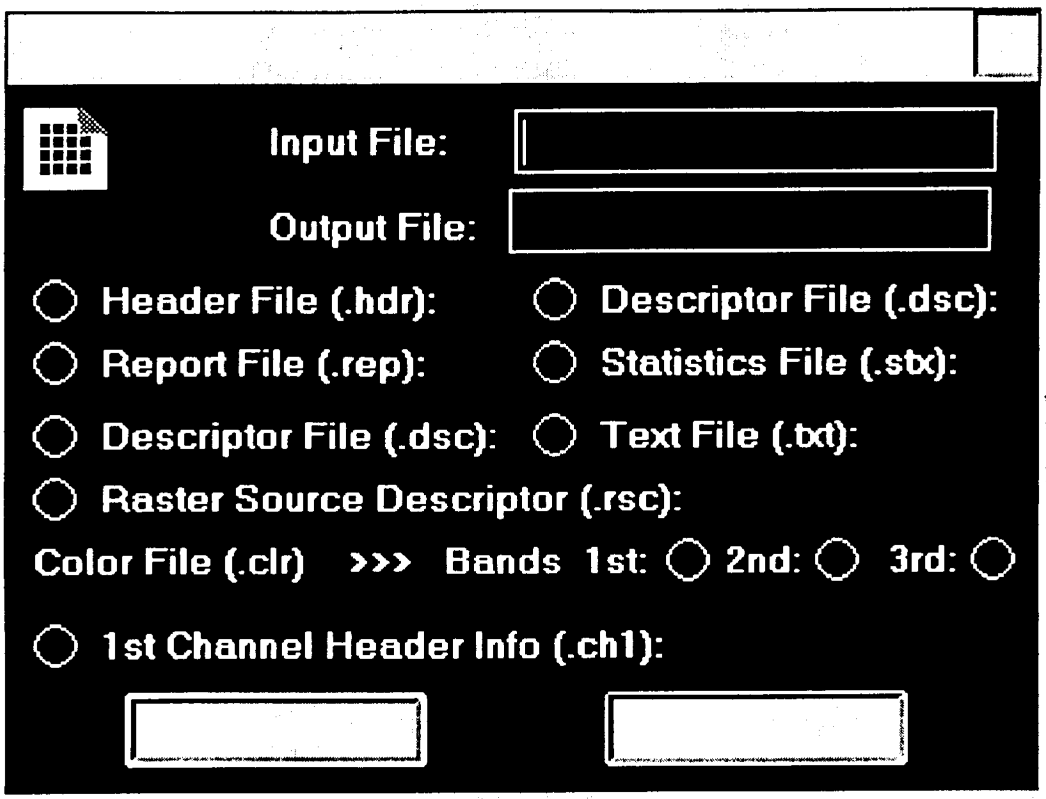

Figure 3. Prototype GUI for AIF2BIL Raster Formatter

The retrieval scripts primary purpose is to help in the automatic retrieval of specified files, while conserving bandwidth used by EOC staff during emergency management operations. The script will be placed in the EOC server's cron tab giving only the system administrator the proper permissions on how often it should be executed and which URLs are to be downloaded. This module is complete except for inclusion of the final set of URLs and final testing on the EOC server. Figure 4 gives an example of the data retrieval script.

AML Utilities. A major component of the prototype system is the GIS. It will be used to display and manipulate spatial data coverages with remote sensing imagery. ARC/INFO is the GIS that will be used at the Alabama EMA. It uses a scripting language called ARC Macro Language (AML) for performing operations with the data within ARC/INFO. Most notably for this project, AML scripts, or AMLs, are the tool for creating spatial data coverages from source data. Originally, it was anticipated that AMLs would be required for each of the data coverage to be produced. These would be to convert source digital data into data coverages, build data coverages from hardcopy source data, and perform edge mapping or feature editing on newly developed data coverages.

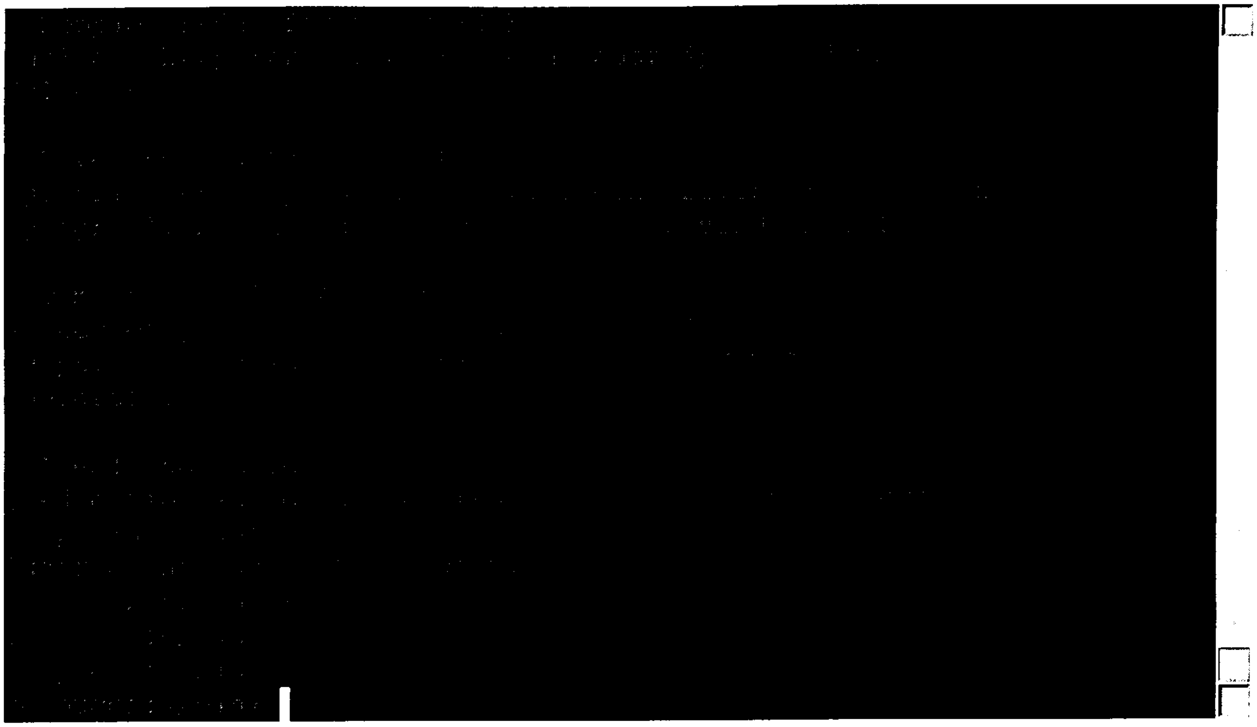

Figure 4. Example Data Retrieval UNIX Script

During the software design phase, it was determined that many of the originally planned for AMLs could be eliminated from those required to be developed. Nearly half of the data coverages planned for the initial version of the spatial database are derived from the U.S. Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) system. SENTAR investigated alternative sources for acquiring the data coverages from companies that already have the necessary AMLs to produce the desired data coverages. It was determined that the data coverages could be obtained more economically by purchasing rather than building the data coverages inhouse, so SENTAR has contracted out to purchase the data coverages derived from the TIGER data from a company in Huntsville. In addition, several of the data coverages that are to be produced from other Federal agency data can also be produced without AMLs. Most notably the Federal EMA (FEMA) Flood Insurance Rate Maps are currently being converted into digital products and one of the export formats will be ARC/INFOs standard export format. The combined result is that half of the originally planned for AMLs have been eliminated from the list of software to be developed. The remaining AMLs to be built are essential for the state source data. None of these have been built yet as these data sets have not been acquired yet.

ArcView Avenue Interface Scripts. SENTAR is anticipating the development of several customized ArcView Avenue scripts, which is a feature provided in the ArcView versions 2.0 and greater. The determination and creation of these scripts will be based on the input from EMO staff after the ArcView software has been successfully loaded and tested within the EOC facility and the GIS databases are loaded onto the SUN Server; currently scheduled for July

Scripts for software initialization, and the reconfiguring of the ArcView interface with customizable buttons and menus are among a few modifications that are planned. At the present time these scripts have been temporarily put on hold and no modules have been developed.

Data Parsing/Extracting Scripts. The data parsing/extraction applications where originally intended to generate reports from NWS forecasts and other documents from various Internet sources. Since the last milestone report, SENTAR has learned that the EOC has a direct connection to the NWS Weather Wire. Since this wire service provides the most current detailed reports of weather, river, and flood conditions for Alabama, the development of scripts has been reoriented to extracting the information from the receiving terminal at the EOC. This module is now being redesigned; no code development has begun yet.

Georeferencing Oblique Aerial Photography. SENTAR researched the use of non-professional aerial photography during the fifth milestone period. Based on previous work, SENTAR addressed the limitations of the available satellite imagery. Most notably these included availability of the satellite over the site of interest at the time of interest, lack of visibility due to cloud cover, the processing and delivery time from the satellite data producers, the resolution of the imagery, and the cost of the imagery. The use of aerial photography has the potential of eliminating most of these limitations, although professional quality aerial photography is equally expensive as the satellite imagery. An alternative is the use of non-professional photography. An example would be photography taken by the Air National Guard which already supports the Alabama Emergency Management Agency, or even amateur photography taken by anyone with access to an aircraft and a camera. A critical question with this approach is the ability to georeference photographs taken at oblique depression angles for integration into the GIS.

To address this question, SENTAR performed a short parametric analysis on a series of aerial photographs taken aboard a small aircraft using a standard 35 mm camera. The analysis looked at aerial photography at altitudes of 1000 to 9,000 feet above the local terrain, at a series of depression angles, and at four geographical positions relative to a fixed ground location. These photographs were then scanned into a digital format, enhanced for visibility, and then georeferenced. As the depression angle increased, particularly for the higher aircraft altitudes, the distortion of the georeferenced image increased. While this was expected, the more interesting conclusion is that there appears to be sufficient accuracy in the georeferencing to meet the needs of emergency management operations. Figures 5 and 6 show the before and after results of two georeferenced photographs at different depression angles. Both photographs were taken at an altitude of 9000 ft above the local terrain. In each figure, the before image is as seen in the original photograph and the after is the processed image with overlaid road and hydrology vector files. Figure 5 was taken on a due east heading looking south, with a 45° aircraft bank angle and an approximately 40° camera depression angle. Figure 6 was taken on a due west heading looking north, with a 0° aircraft bank angle and an approximately 40° camera depression angle. The increased distortion in Figure 6 is clearly evident in the image as the distance from the camera to the ground increases and the ground area per pixel increases. In addition, the accuracy of the georeferencing in these portions of the image is reduced. The overlaid road and hydrology vector files are clearly less accurate in the lower portion of the image in Figure 6. Note that in both figures the matching of the vector files and the image is not exact, but is clearly

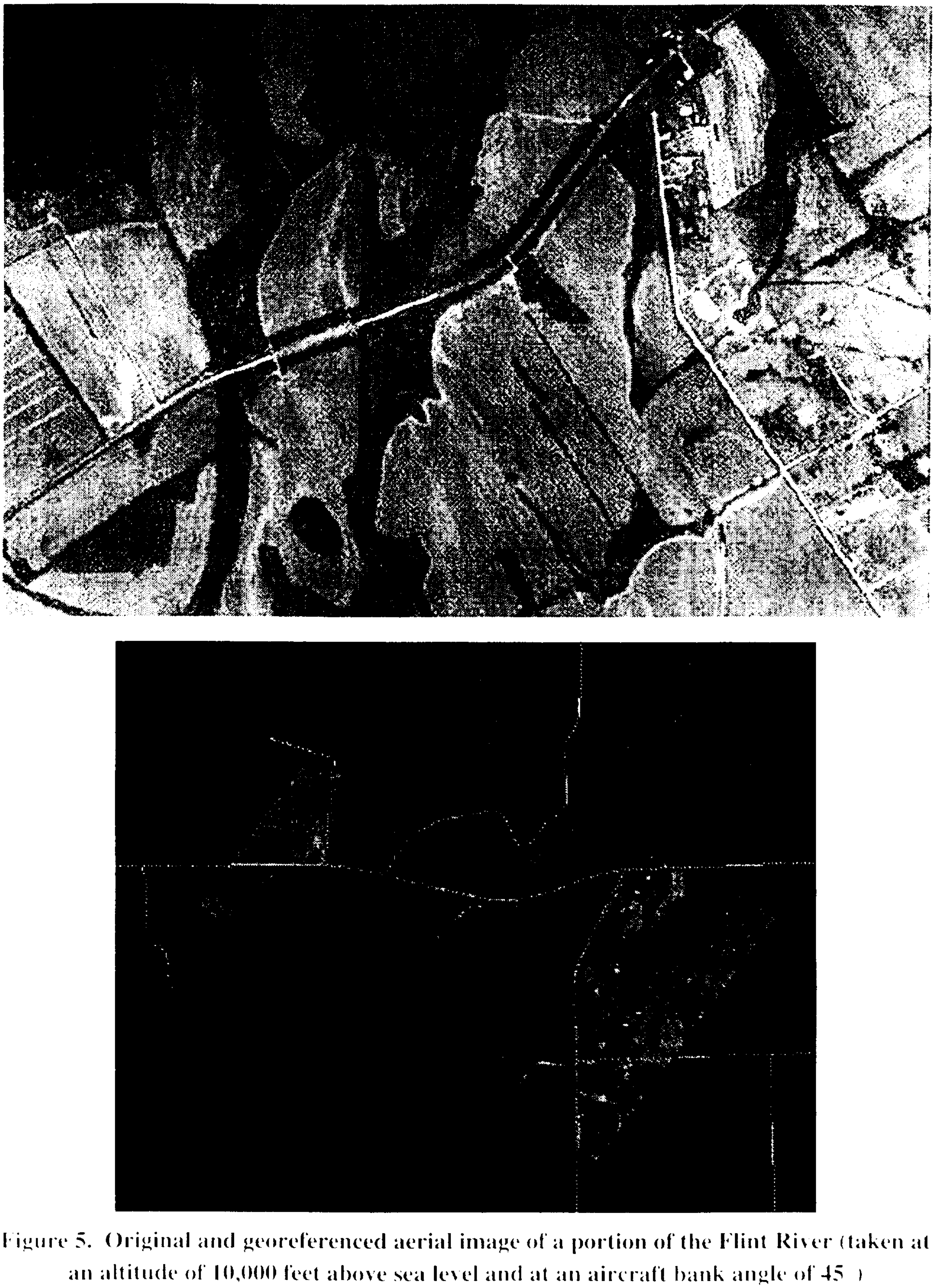

Figure 5. Original and georeferenced aerial image of a portion of the Flint River (taken at an altitude of 10,000 feet above sea level and at an aircraft bank angle of 45°)

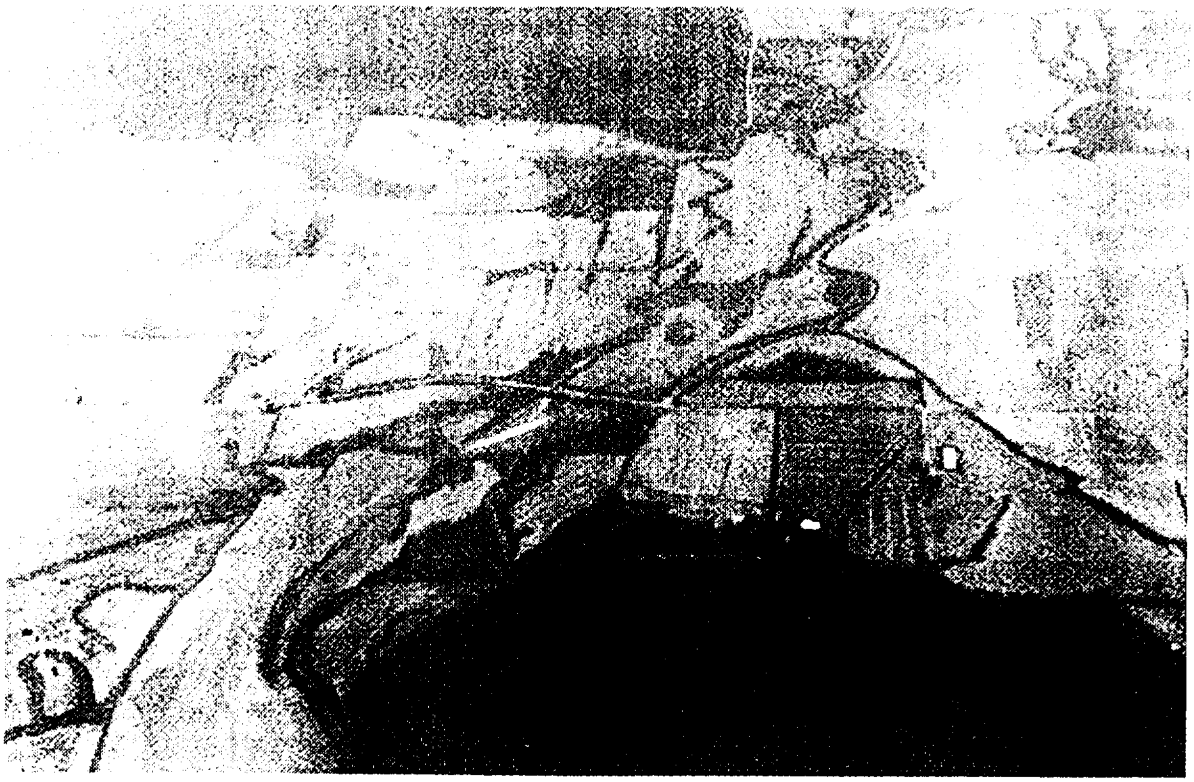

Figure 6a. Original aerial image of a portion of the Flint River (taken at an altitude of 10,000 feet above sea level and at an aircraft bank angle of 0°)

close enough to perform a graphical analysis of the effect of flooding, as depicted in the image, to the various vector data layers.

One limitation of the aerial photography versus the satellite images is the reduced areas of coverage. This was particularly true for the test photographs taken by SENTAR. We were using a light aircraft with a ceiling of 10,000 feet above sea level (or 9000 feet above the local terrain for the area photographed). To compensate for this and also to remove some of the heavily distorted areas of an image, multiple georeferenced images can be combined in a mosaic, as shown in Figure 7. Here three images of the same area have been combined to produce a composite that provides a wider area of coverage. The three images used for this composite image were taken at altitudes of 3000 and 9000 feet above the local terrain; aircraft bank angle of 0°, 20°, and 45°; aircraft headings of south, north, and east; and a camera depression angle of approximately 40°. Figure 8 presents a slide that was developed for briefings that summarizes the methodology used to create the image of Figure 7. A similar approach can be taken to create a mosaic image that covers a length of a river or an extended area.

The intent is to export these images to the EOC where they will be used within the GIS with the feature data layers. They can also be combined with other images, such as hardcopy maps to produce static maps for distribution to those without the GIS software. Figure 9 provides an

Figure 6b. Georeferenced aerial image of a portion of the Flint River (taken at an altitude of 10,000 feet above sea level and at an aircraft bank angle of 0°)

Figure 7. Mosaic image of three aerial photographs taken at different aircraft altitudes, headings, and bank angles.

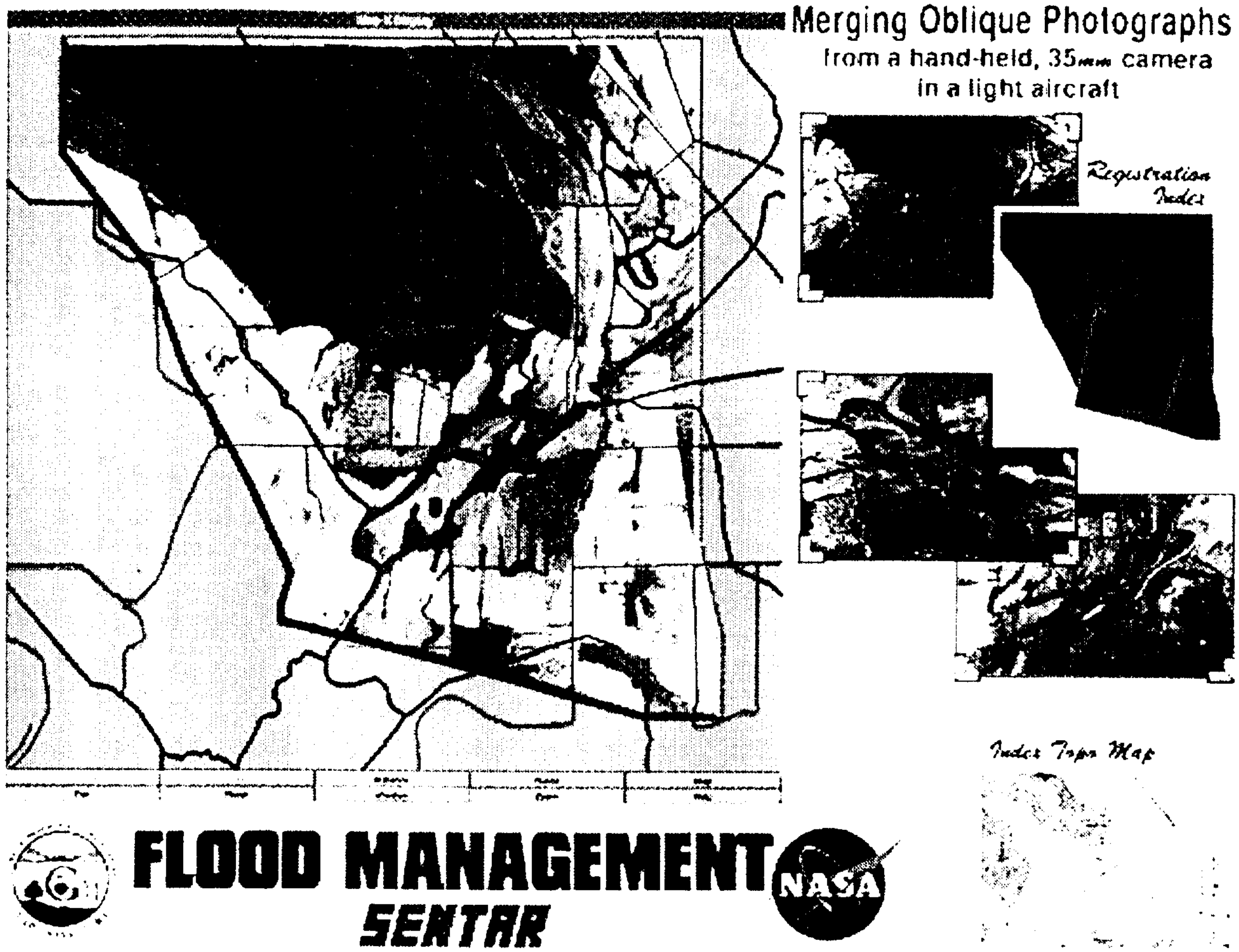

Figure 8. Slide summarizing the process of mosaicing three images to create a composite of the aerial photograph images.

example of this for one of the aerial photographs with vector data for the roads and hydrology and the USGC hardcopy map for those areas beyond the limits of the photographic image. A side benefit of the aerial photographs is that they provide current information on some of the feature data of the GIS data layers as well as providing information on the effect of the disaster. Specifically, in the test images along the Flint River, we were able to see how roads have been changed or added. Similarly, changes in streams were noted, primarily due to manmade changes for road construction or agricultural reasons. This side benefit is significant because it can provide emergency management staff with more accurate representations of the area than in the feature data layer and because it can provide those familiar with the area with greater confidence in the GIS-based system. When the GIS data layers do not accurately reflect the spatial feature as the user knows it, the user loses confidence in the entire data layer and eventually the system itself.

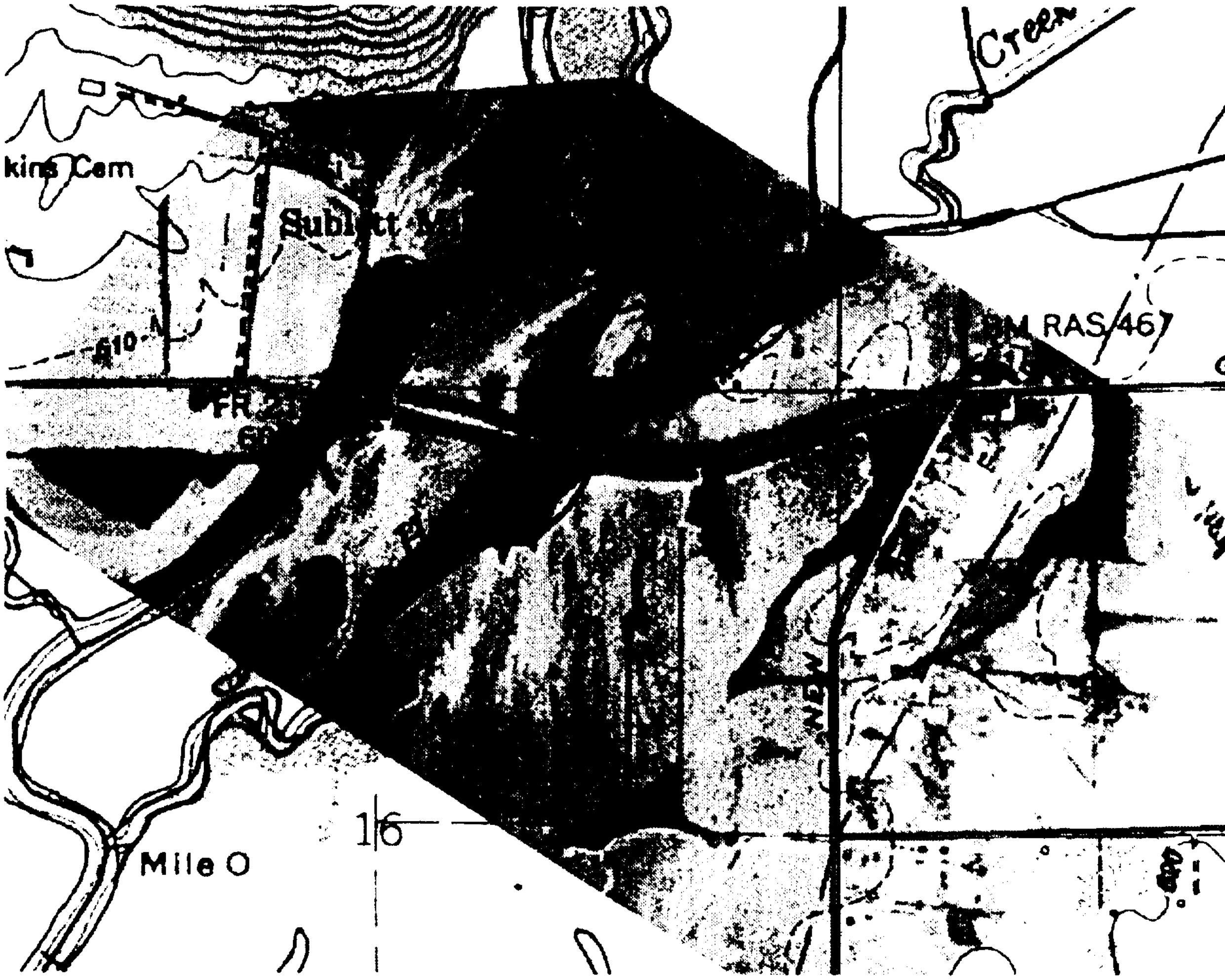

Figure 9. Example of a static map composed of an aerial photograph, USGS hardcopy map image, and vector feature data for roads and hydrology.

The use of satellite and professional imagery will always be a primary source of remote sensing data where available, however this effort has also shown that the use of non-professional, oblique-angle aerial photography also can be of value to emergency managers.

GIS Data Layer Development. There was some development of the GIS data layers for the prototype system during this milestone period. SENTAR began acquiring the necessary source data to support the data layers for the Alabama counties to be included in the prototype system. The desired data layers previously defined with Alabama EMA for the prototype system were divided into three categories: Those that can be produced from the U.S. Census Bureau's TIGER data, those that can be obtained form other federal agencies, and those that will be obtained from state sources. TABLE 1 groups the desired data layers these three categories.

The TIGER-derived data layers are essentially the data layers that were provided by the US Army from the Integrated Disaster Planning Package (IDPP). The IDPP data are from 1990 TIGER data and so will only be used for testing and training purposes. SENTAR has contracted out for new sets of these data layers using the most version of TIGER data. The IDPP data for

TIGER data and so will only be used for testing and training purposes. SENTAR has contracted out for new sets of these data layers using the most version of TIGER data. The IDPP data for the 10 northern most counties of Alabama were provided to the Alabama Emergency Management Agency until the new data sets are ready.

The next category are the other federal agencies. For these data layers the desired data are either already on-line or available via electronic media with the exception of the Flood Insurance Rate Maps (FIRM). FEMA currently has FIRMS on-line for 10 counties in the US, which are called Digital Q3 Flood Data. They are scheduled to have more than 800 counties across the US completed by this summer and available on CD and on-line. Through discussions with FEMA staff, SENTAR was informed that FEMA is now intending to put all the Q3 flood data on-line and that the 19 Alabama counties that Digital Q3 Flood Data is being generated for will be ready by late July. Currently one Alabama county, Coffee county, is available in the Digital Q3 Flood Data. Figure 10 illustrated what is provided for Coffee county. Finally, the Digital Q3 Flood Data is available in ARC/INFO's export format (i.e., <filename>.e00), so no AML will be required to import for use in ARC/INFO or ArcView.

For the state agency data, the appropriate agencies were previously contacted via telephone and discussions were held at a technical level. With the exception of the Alabama Department of Transportation, all the other data desired are currently not in digital form. Currently, official requests from the Alabama Emergency Management Agency are being sent to each affected agency to solicit their support in this effort. During the next milestone period, we anticipate that agreements with some state agencies will be completed so some of the state agency data can be brought into the GIS.

Georeferencing Procedures. SENTAR has received extensive technical support from our GHCC teammate on georeferencing procedures and techniques. SENTAR has captured the expertise provided into a set of georeferencing procedures that will aid us in future work in this area. Although some of the procedures are specific to the particular remote sensing software we are using (i.e., MapiX), the basic operations and steps are not unique to this software package. One of the lessons learned during the course of our work is the need for human expertise in the processing of remote sensing data. Although the remote sensing software is very powerful and easy to use, there is still a need for human expertise to produce quality results. Thus, our goal was to capture what was practical of the expertise currently supporting us. With the documented procedures less experienced individuals can perform the most mechanical operations of the processing with minimal support from a remote sensing expert in most cases.

Other Activities

Initial GIS and Remote Sensing Data. Initial GIS data sets were loaded onto the network at Alabama EMA. These data sets were for the 10 northern most counties of Alabama, and provided data for the GIS data layers identified in TABLE 2. These data sets were provided by the U.S. Army Integrated Disaster Planning Package (IDPP) and will be used for testing of the prototype system during development. Replacement data sets are being purchased to provide the most current source data for these data layers. Some sample satellite and aerial photography images of the Madison County area were also delivered to Alabama Emergency Management Agency for use in the ArcView GIS with the IDPP data layers. Alabama Emergency

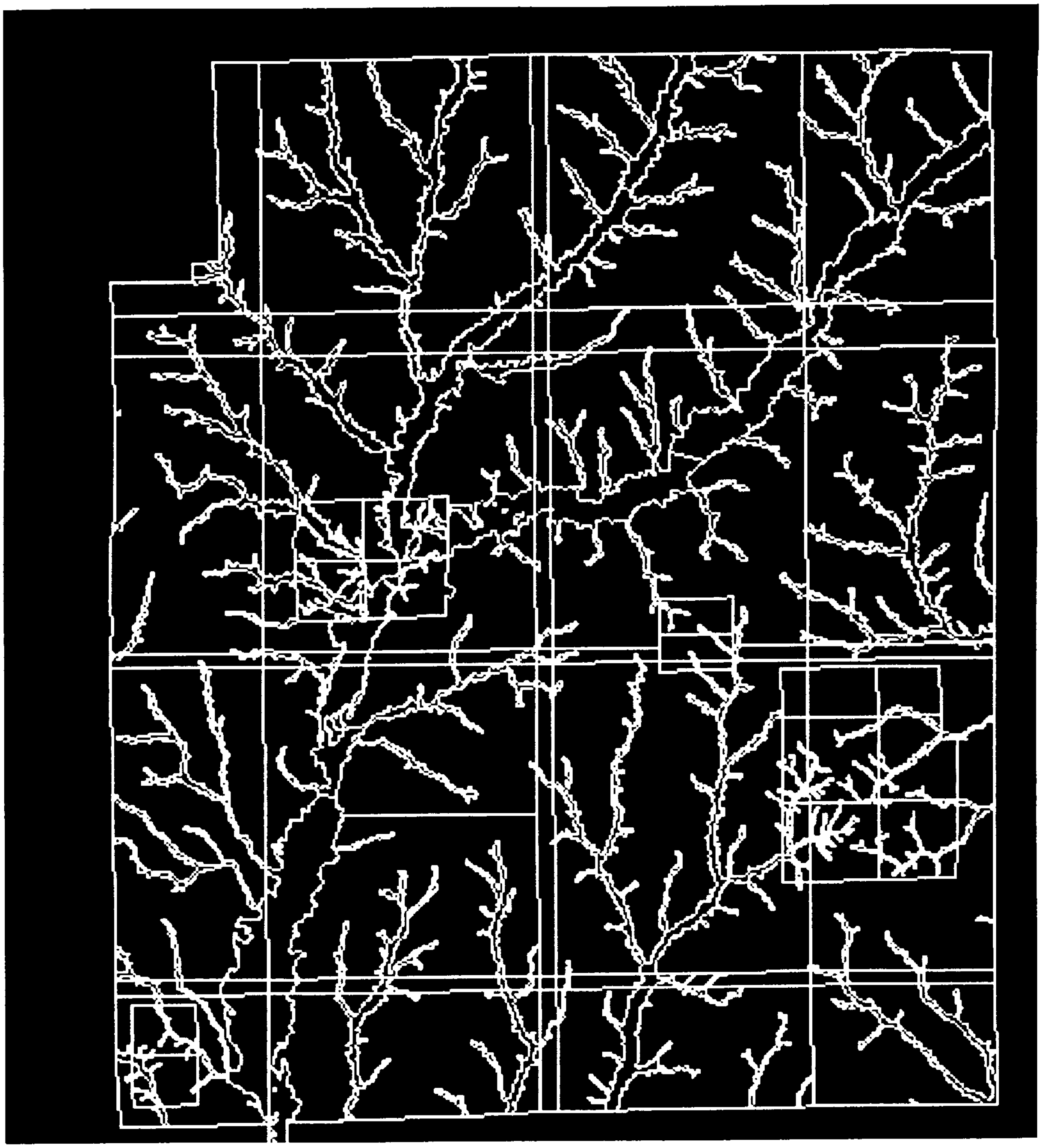

Figure 10. FEMA Q3 Data for Coffee County, Alabama

TABLE 1
DATA LAYERS BY BROAD DATA SOURCES

Data Source	Data Layer
TIGER	Hydrography, boundaries (local, county, state, and international), built up areas, census geography, demographics, roads and streets, railroads, and airports
Other Federal Agencies	Flood Insurance Rate Maps, elevation contours, surface geology, USGC control points, land use/land cover, surface temperature, snow cover, flood warnings
State Agencies	Fuel facilities, EAS radio coverage, fresh water systems, sewer systems, water/sewer treatment plants , solid waste disposal sites, burn sites, federal boundaries, hazardous/toxic/radioactive waste, hazardous materials, medical waste, nuclear plants, EOCs, hospitals, designated shelters, bridges, pipelines, power plants, police and fire departments, historic standing sites and graveyards, evacuation routes, nursing homes

TABLE 2
IDPP DATA LAYERS DELIVERED TO ALABAMA EMA

Hydrology	State Boundaries
Roads	County Boundaries
Railroads	Local Boundaries
Hospitals	Nuclear Power Plants

Management Agency is in the process of upgrading their computing resources with a Sun server and Pentium-class PC. Once these systems are installed and ArcView is loaded on the PCs, the operations staff can begin using the data layers and remote sensing images. These upgrades are underway and are scheduled to be completed by the end of June.

New Satellites. During this milestone period, three new satellite systems were identified that will provide additional sources of remote sensing imagery. These are all commercial satellites systems. The companies running these systems are: EarthWatch, ORBIMAGE, and Space Imaging (a partnership of Lockheed/Martin, Raytheon/E-Systems, Mitsubishi, and Eastman Kodak). All three satellite systems will produce high resolution imagery (1-3 meters), with generally shorter revisit times than is currently available with Landsat or SPOT. SENTAR has contacted all three companies to discuss getting sample data for testing with our developing system. None of the systems are currently operational, but we will continue our contacts with them to track their progress and determine when actual data will be available. These companies provide general information their systems via World Wide Web home pages at:

EarthWatch -- http://www.digitalglobe.com/ewhome.html

ORBIMAGE -- http://www.orbimage.com/orbview/prodapps.htm

Space Imaging -- http://www.spaceimage.com/home/contents.html

TABES. In May the annual Technical And Business Exhibition/Symposium (TABES) in Huntsville was held. TABES is sponsored by the Huntsville Association of Technical Societies (HATS) and features a comprehensive forum for leaders in defense, space, business, and technology. The theme for TABES this year was "Creating Partnerships for Economic Growth". Under the Defense portion of the Program, Peter Kiss, SENTAR's CEO, presented a briefing on our Flood Management project. The focus of the presentation was the creation, contracting, and execution of a cooperative agreement effort. Our effort was of particular interest since our team includes industry, the Federal government (NASA and USASSDC), and state government (Alabama EMA).

Home Page. During this milestone period the project home page underwent only minor changes. The demonstration section has some of the aerial photography added and the documentation section to include the latest documents (i.e., the last milestone and design concept document) and the TABES briefing. Next milestone period we will integrate the Emergency Management Tool into the demonstration section as the tool develops.

Problems Encountered

Internet Connectivity. Alabama EMA is still in the process of establishing Internet access through the Alabama Supercomputer Network operated by the Alabama Supercomputer Authority. Until this access is implemented, Internet access has been provided through the MSFC GHCC using their 800 dial-up service. Current plans are for the Internet connectivity to be established through Alabama Supercomputer Authority in July.

Workstation Availability. The U.S. Army Silicon Graphics workstations we use for running ARC/INFO have been down through April and May as the equipment is being relocated within the main Space and Strategic Defense Command (SSDC) facility from the satellite offices it was located in. The length of the down time has had some impact to us, however, having the equipment back in SSDC will be beneficial to us due to the additional support staff that will be readily available to us. The equipment transfer is scheduled for completion by mid June.

Budget Uncertainty. The federal budget impasse between Congress and the President has been resolved, however the impact during the first part of FY96 has caused additional delays in our progress. There still has not been a contract modification for FY96 to state NASA's funding commitment for FY96.

Data Acquisition. The planned purchase of additional satellite data was delayed until the budget uncertainties were resolved. Currently we are working with RSPAC and EDC to resolve continuing cost questions related to low cost Landsat archive data and their availability to us under the Cooperative Agreement with NASA. The images still to be purchased are the base images for the flood prone regions of northern and southern Alabama.

Requests for Assistance from NASA

The technical assistance requested from NASA GSFC during this milestone period consisted of guidance as to how and at what level to proceed with the effort, considering the budget uncertainties.

Technical assistance was provided by RSPAC and a site was made by Rick Vandenbossche, our RSPAC technical contact. During this visit, we reviewed the activities and progress of the project and explored areas where RSPAC can support us. In particular, Rick will be helping to identify possible points of connection between our project and the other Cooperative Agreement Teams (CATS). This is a role only RSPAC has the visibility of the projects to accomplish. The primary technical support from RSPAC involved development of a UNIX script for automated and periodic downloading of FTP, Gopher, and Web server files. In addition, RSPAC has provided answer to various questions related to our home page and possible upgrades to it. Support was also provided by Joe Gardner related to remote sensing data and image processing software. He aided us in becoming an Affiliated User under the Multi-Resolution Land Characteristics (MRLC) project for acquisition of low-cost Landsat TM imagery. He also provide technical information on various image processing software. Where he did not have personal knowledge, he provided contacts to current users.

PLANNED ACTIVITIES

The planned work activities for the next milestone period are:

1. ***Develop Prototype System Software.*** The remaining components of the prototype system software will be completed. This consists of completing the EMO Tool interface and connecting of the other applications, developing AML scripts for source data conversion and coverage correction, developing the ArcView Avenue interface scripts to tailor the graphical interface to meet the results of the user feedback, and integrating the data retrieval script onto the Sun server at the Alabama EMA EOC. Draft versions of the EMO Tool will be delivered to the Alabama EMA during the sixth milestone period for the operations staff to test and evaluate as it develops.

2. ***Acquire and Process Backdrop Remote Sensing Images.*** Additional Landsat images will be acquired to complete coverage for the areas of northern and southeastern Alabama for the areas of the prototype system. These images will define the normal (i.e., non-flooded)

condition for these areas. Each image will be processed at the GHCC, converted into a format for importing into ArcView, and then transferred to the Alabama Emergency Management Agency EOC. SENTAR will also acquire satellite images during previous floods to support the Experiments and Demonstrations.

3. ***Acquire Remote Sensing Data from Other Source Providers.*** SENTAR will complete previously initiated discussions with other remote sensing data producers on developing procedures for identifying and acquiring imagery from them during future floods. Particular effort will be to explore the use of new on-line support tools provided by the data producers such as SPOT Image Corporation's Device to Access and Look AT Spot Inventory (DALI) system.

4. ***Airborne Photography.*** SENTAR previously investigated the use of non-professional aerial photography to avoid the identified limitations in using satellite data due to issues of infrequent satellite availability over disaster areas, long processing time to acquire processed data from providers, cloud cover, and data cost. The use of airborne photography can eliminate many of these issues, but causes other issues in terms of the small area of coverage and distortion due to greater incidence angles of the camera to the ground. SENTAR acquired additional airborne photographs of portions of the Tennessee River during the fifth milestone period to expand its work in mosaicing of the aerial photographs. Selected numbers of these photographs will be processed into georeferenced image files and converted for use in the ArcView GIS during the sixth milestone period.

5. ***Collect Available Source Data for GIS Data Layers.*** The data layers derived from TIGER data will be purchased and transferred to the Alabama Emergency Management Agency EOC. The other federal agency source data will be acquired and converted into ARC/INFO formatted files, and also transferred to the Alabama Emergency Management Agency EOC. Lastly, SENTAR will work directly with the staff at the Alabama Emergency Management Agency to forge agreements with Alabama state agencies to acquire source data for the remaining desired data layers.

6. ***Refine Experiment/Demonstration Plans.*** The Experiment/Demonstration Plan developed by SENTAR during the fifth milestone period will be coordinated with the operations staff at the Alabama Emergency Management Agency to develop the detailed operational steps to implement the planned experiments/demonstrations.

7. ***Continue Home Page Upgrade.*** The project home page structure will be modified to include the Emergency Management Tool. Although the Emergency Management Tool is not inherently a Web-based product, we will create a Web-based demonstration on how it works. We will also start putting some of the aerial photography that have been converted into georeferenced images (i.e., .BIL files) on-line for other ARC/INFO and ArcView users to download and experiment with. Some feature data layers files will also be put on-line for others to download and use with the image files.

Government-Industry Partnerships

"Emergency Management Using Remotely Sensed Data"

Presented at TABES '96

by

Peter A. Kiss

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Emergency Management Using RSD

Objective

Present a case study of a new paradigm for doing business with the Government.

Contents

Paradigm Shift
The Project Objectives and Concept
The Team
A Brief Case History
Technical Results
Lessons Learned

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Paradigm Shift

<u>The Old/Standard Way of Doing Business</u>

- Government has <u>all</u> the gold and makes <u>all</u> the rules
- Rigid procedures and protocols
- Us vs. Them
- Government directs, controls, and manages contractors
- Contractors benefit from increasing project scope
- Government restricts sharing of equipment and facilities
- Government internal accounting very loose

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Paradigm Shift (Cont'd)

A New Way of Doing Business

- Everyone has some gold and invests it.
- Working relationships developed using flexible procedures and protocols for mutual benefit.
- Participants work as a team to meet joint and individual goals.
- Government optimizes use of taxpayer money. Can play a supportive role to industry and transfer technologies.
- Contractors can benefit from product rights.
- Government maximizes utilization of equipment and facilities.
- Full cost accounting within Government for projects.

The goals of Government and industry become complementary; greater cooperation leads to optimized available resources.

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Project Goal and Objectives

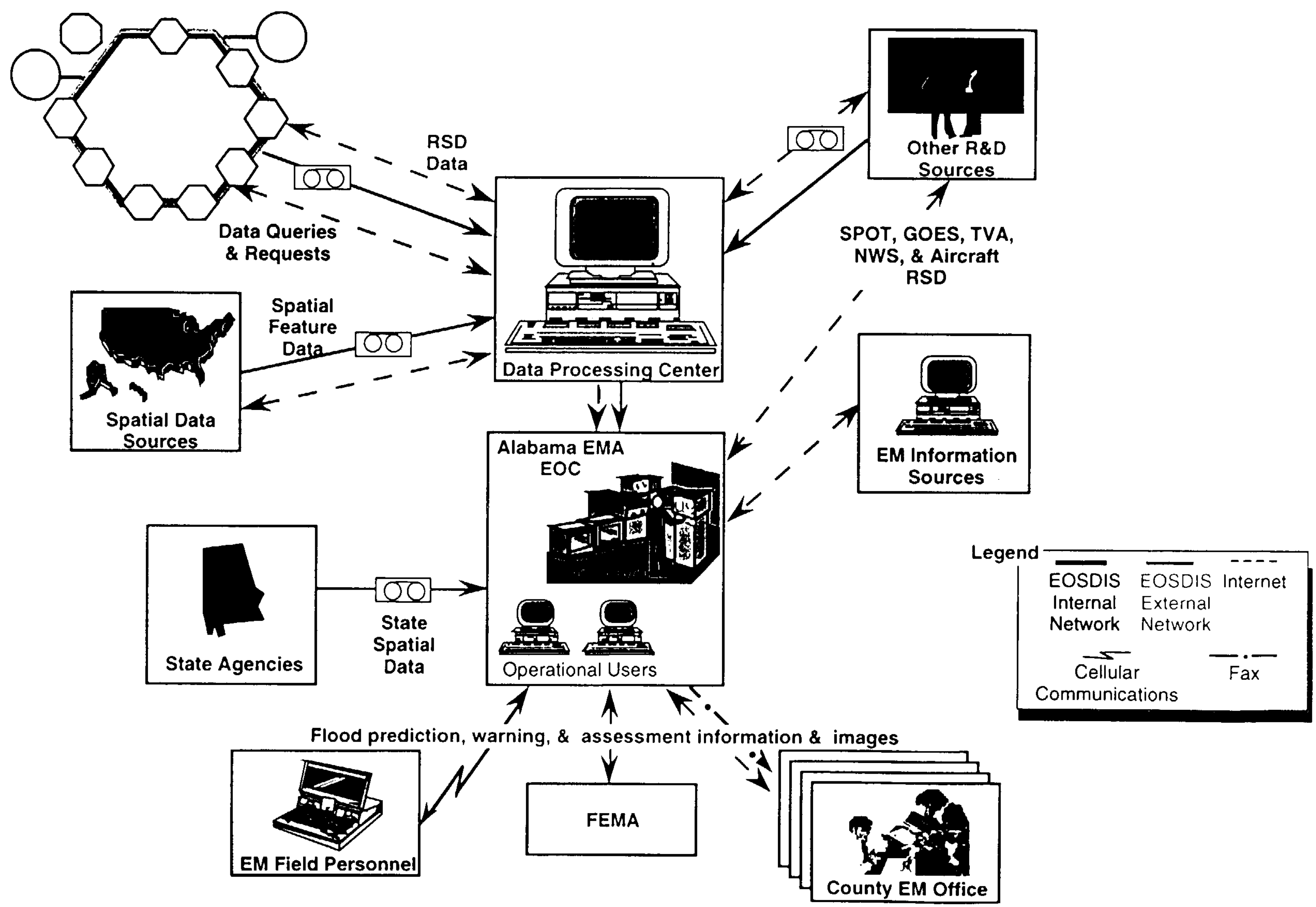
Project Goal

Develop a prototype system that integrates remote sensing and spatial feature data into an emergency management tool to support disaster emergency activities for floods.

Project Objectives

- Show the value added of Remotely Sensed Data (RSD) to disaster management.
- Develop concepts for communicating data from source to field utilization. Heavy emphasis on National Information Infrastructure (NII).
- Demonstrate a concept for flood disaster management in a realistic environment.

Current Design for System



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The Team: Roles, Goals, and People

Team

GSFC
- Initiator, customer, & supporter
- Increase utilization of NASA remote sensing resources and the Internet/NII
- Dr. Fritz Hasler, Alan Nelson

SENTAR, Inc.
- Prime contractor & integrator of system
- Provide challenging work for employees. Commercial business potential.
- Greg Romanowski, Greg Hodges, Jeff Yalowitz, Peter Kiss, Fred Roberts

USASSDC
- Provide GIS resources
- Enhance partnership for peace & add remote sensing to SWSA capability
- Roger Qualls, Curtis Miller, Russ Alexander,

MSFC
- Provide coordination & international EM information
- Build support & capability for Geowarn program
- Angie Bukley, Jack Mulqueen

GHCC
- Provide remote sensing, image processing, & DAAC expertise
- Increase application & utilization of Remotely Sensed Data
- Doug Rickman, Dr. Ron Greenwood

AEMA
- Future user of system & requirements developer
- Enhance EM capabilities with technology
- Scott Adcock, Jerry McRay

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A Brief Case History

	FY93	FY94	FY95	FY96
Prior Activities	• Support to MSFC on Geowarn concept and plans			
Proposal Period		RFP • Develop concept • Recruit team		
Post-Proposal			• MOAs signed	
First Milestone Agreements			Award • GSFC - Cooperative Agreement • AEMA - Cooperative Agreement • MSFC - Space Act Agreement • USASSDC - Cooperative R&D Agreement	
Subsequent Milestones				• Requirements • Design • Development • Demonstration

New territory for all organizations. Hearts were in the right place, but systems did not support it (e.g., contracts, legal).

96-0238 J-8

A Brief History: The Resources

Background

- Initial concepts and MOAs were established, mostly at technical levels.
- Final agreements were signed at the top levels.

Some Changes Along the Way

- USASSDC had reorganized and GIS focus changed.
- Governor of Alabama and, hence, AEMA director changed.
- GHCC was created and given responsibility for the project.

Resources Required/Requested or: "You want what? Who signed up to this?"

- People: We can't spare them! Who is going to pay for them?
- Hardware: No Internet connection, no maintenance agreements
- Software: Old version of GIS and operating systems, no maintenance agreements
- Data: Remote sensing data from DAACs could run as high as $5,000 per scene (none costed) and not timely

Commitments should bind partners, not interpretations of legal documents.

A Brief History: Getting Started

Once the dust settled . . .

- SENTAR developed a multi-level Internet home page for the project to communicate (November 1994). (http://iquest.com/~sentar)
- Began working with AEMA to develop requirements.
- USASSDC provided a Silicon Graphics computer and ARC/INFO GIS software along with work space at their Systems Analysis Center.
- GHCC provided a remote sensing expert, use of computer equipment, use of Internet access (especially for AEMA), and some DAAC data.
- The team began work on the design.

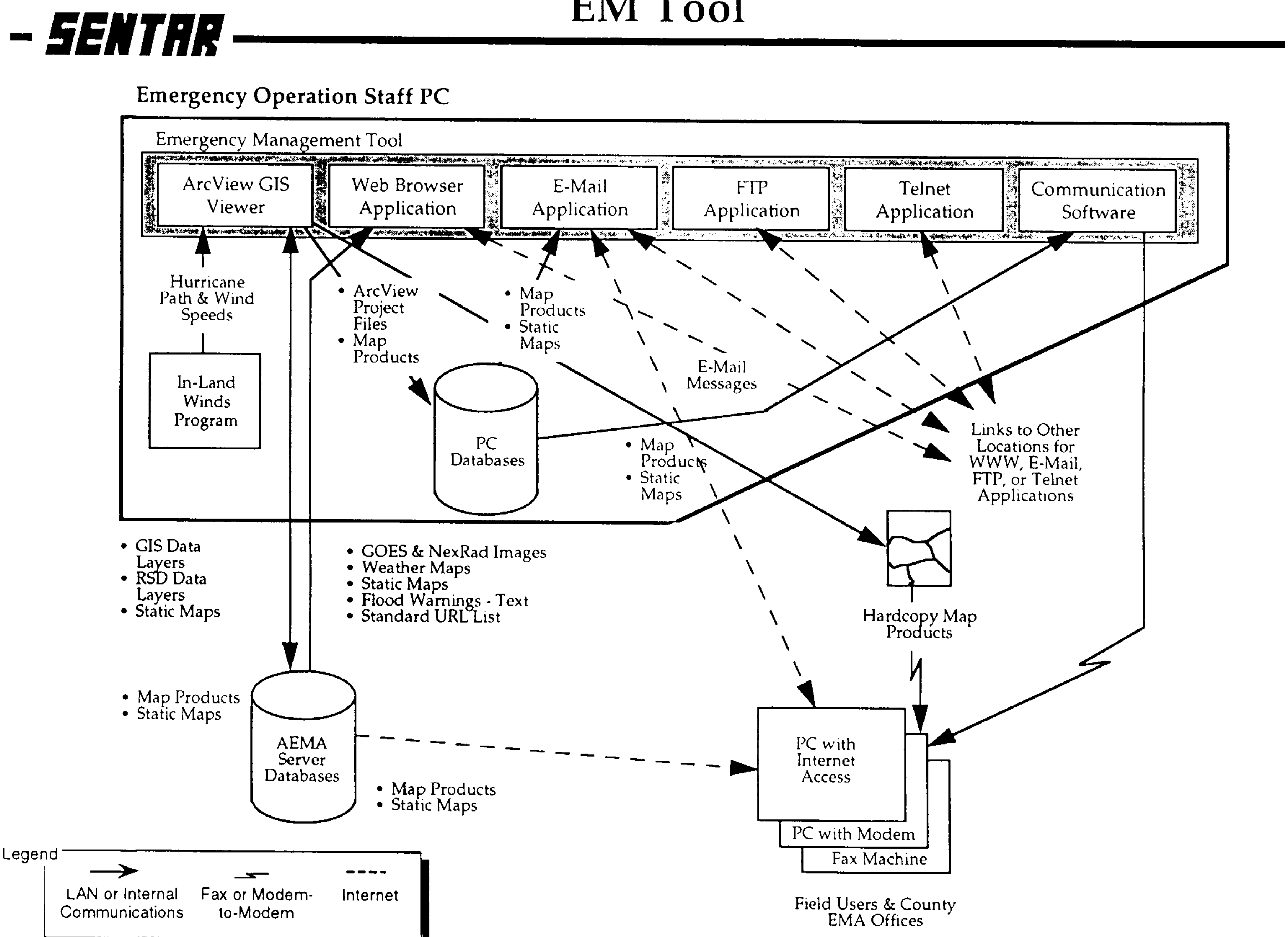
Working at technical level was very cooperative.

Accomplishments and Status

- Completed a set of requirements with AEMA.
- Got SSDC hardware/software up and running with Internet connection.
- Got AEMA on the Internet using a NASA account.
- Completed prototype designs.
- Developed satellite image overlays on GIS.
- Developed merging of oblique aircraft photos.
- Developing and integrating Emergency Management tool.
- Prototype demonstration at AEMA planned for November 1996.

Overcame many obstacles by working as a team and helping each other.

EM Tool



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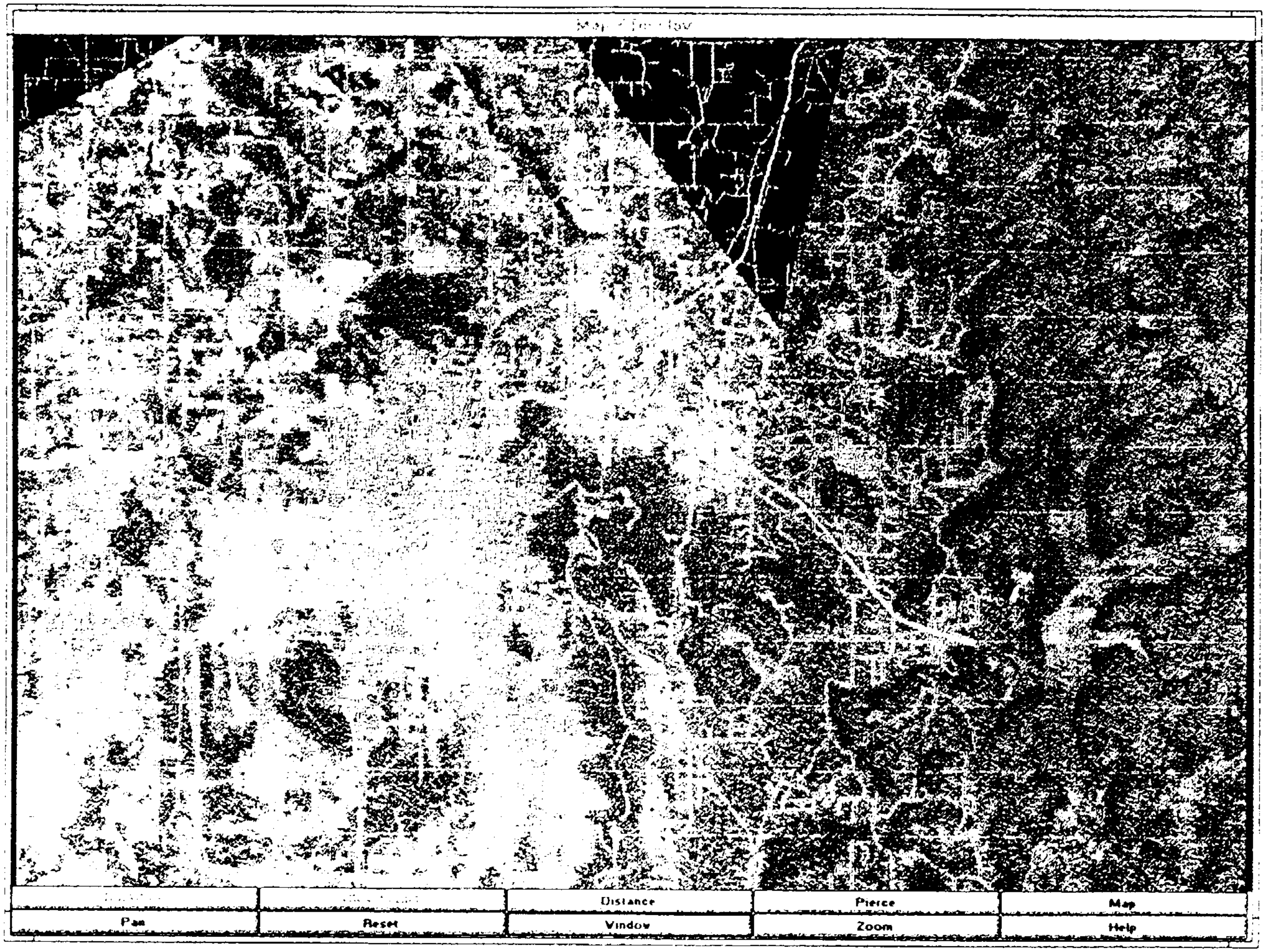
Merging Shuttle - Landsat - DLGs



FLOOD MANAGEMENT

SENTAR

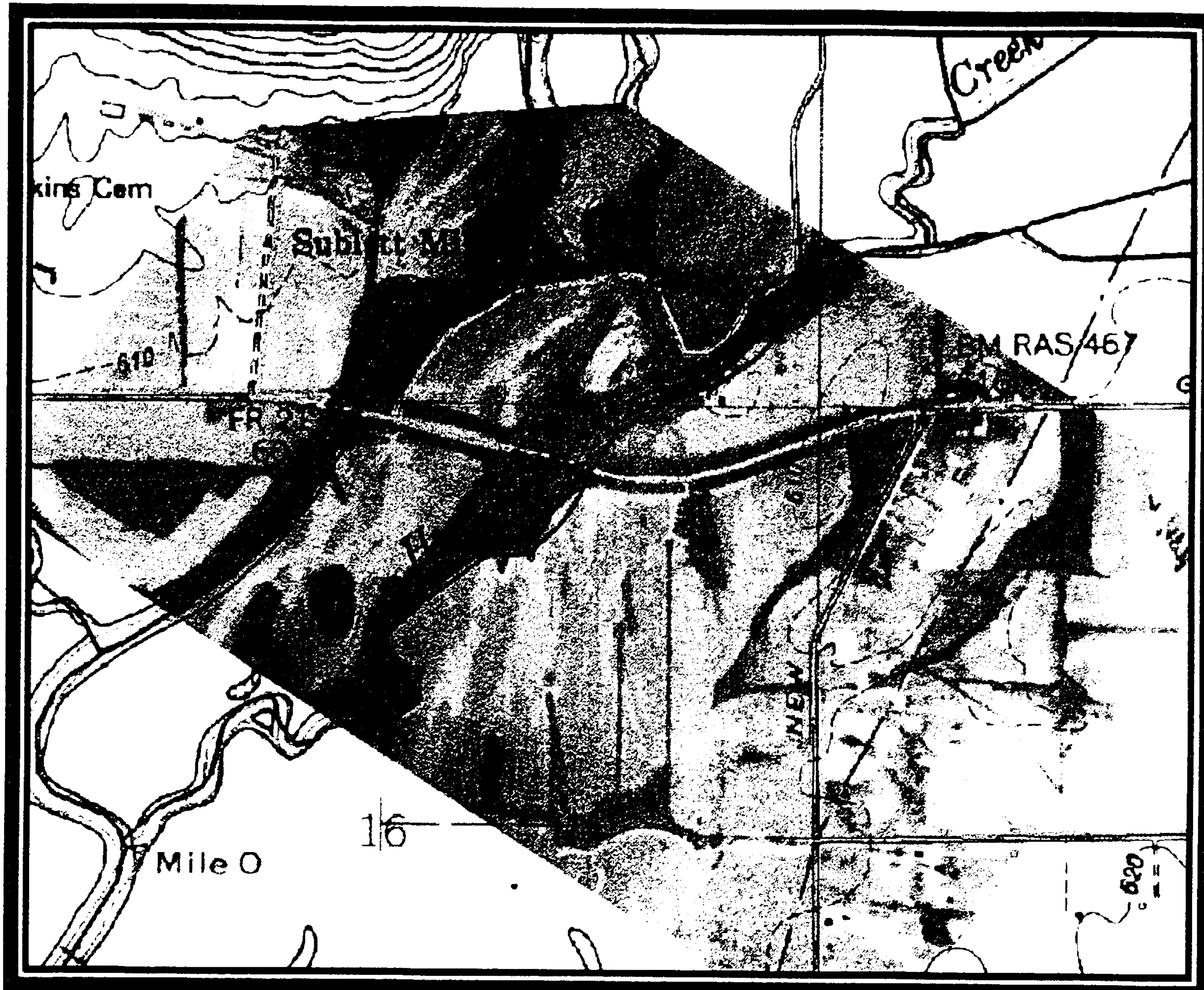
Doug Rickman May 9, 1996

Merging Oblique Photographs

from a hand-held, 35mm camera
in a light aircraft

Index Topo Map

FLOOD MANAGEMENT
SENTAR



Merging Hand Held Camera - DLG - Map Sheets
For Flood Response & Management

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Lessons Learned

The Buy-In

- Must have measurable value added to all participants.
- Get buy-in and commitment at working ranks (tend to stay more stable).
- Get concepts in front of all players up and down the chain before committing to project.
- Put as much detail as possible together to support MOA. Get commitments.
- Decide contractual forms up front, if possible.

Get firm commitments.

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Lessons Learned (Cont'd)

Rolling with the Punches

- Respond to organizational changes in team quickly.
- When "policy" changes so does the perception of what is beneficial.
- Changes are inevitable; have fallback positions.
- Know the priorities of your teammates and learn how to work with them (e.g., disasters for AEMA)

Stay flexible.

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Lessons Learned (Cont'd)

Keeping It Going

- Industry can't motivate Government with profits. Need motivational ideas.
- Early efforts are critical. Develop accomplishments and demonstrate value ASAP.
- Support each other as needed to overcome obstacles for the success of the project.
- Have plans for surviving Government multi-year budgeting process.
- Develop risk management plans and have estimates and reserves for resources you might need to support teammates.

What each partner gains is proportional to investments made.

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Conclusion

Government-Industry cooperative ventures
can succeed

IF

all participants stand to benefit and are
willing to change and be flexible.